Appendix A5

Assumptions for Regional I/I Control Program

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Both planning and I/I reduction assumptions were developed for I/I modeling and cost effectiveness analysis efforts. The planning assumptions are needed to determine capital conveyance and treatment facilities capacity improvements in the absence of any I/I reduction projects. Certain I/I reduction assumptions are needed to determine what I/I reduction projects are cost effective.

The E&P Subcommittee purposely wanted to be cautious in their assumptions and therefore selected an approach to assumptions that would not overestimate the capital facility and I/I reduction project benefits or underestimate the I/I reduction project costs.

The following sections of this appendix detail both the planning and I/I reduction assumptions followed by a summary table (Table A5-1) of chosen assumptions.

A5.1 I/I Planning Assumptions

Planning assumptions are necessary to extrapolate from existing conditions to maximum sewer system build-out. These assumptions are used to model future facility needs, including size and timing of new sewer system components. The assumptions and hydraulic modeling also provide a foundation for the I/I reduction cost effectiveness analysis. King County and the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC) Engineering and Planning (E&P)

Subcommittee collaborated on formulating the planning assumptions, with the intention that the assumptions:

- Be reasonable and realistic
- Help avoid under-building of sewer facilities
- Help minimize or avoid over-building of sewer facilities
- Lead to facilities that meet the Growth Management Act requirement that the regional system be able to convey wastewater flows from each local agency without overflow when the 20-year flow events occur.

A5.1.1 Design Factors

The County and the Earth Tech Team elected to use the peak sanitary sewer flow that can be expected once every 20 years as the modeling flow for sizing capital facilities and costs. A "design storm" approach was considered but rejected because building a system based solely on the amount of rain from a 20-year storm does not take into account the antecedent moisture conditions. Antecedent moisture is the buildup of groundwater over time that affects total I/I during a particular storm event. For example, antecedent moisture conditions can lead to such high groundwater levels in this region that a rainfall event of 1.3 inches can result in a system flow equivalent to a rainfall event of 1.9 inches.

In March 2004 the County and local agencies, via the E&P Subcommittee, agreed on a design flow of 20-year peak flow plus a 5-percent safety factor. The 20-year peak flow is based on the statistical analysis of 60 years of peak rainfall data from Sea-Tac airport.

A5.1.2 Population Growth Rates

The I/I control program proposed for a maximum sewer system service area population is a straight line extrapolation of the most recent population data and projections from the Puget Sound Regional Council (PSRC). This "saturation" population is projected to occur by 2050. For a residential population, the approximate saturation population is 1,500,000; for commercial, it is 800,000; for industrial, it is 100,000.

In considering the population assumption, the County and E&P Subcommittee discussed several related issues such as urban growth boundaries, traffic zones, and densification.

The County and local agencies, via the E&P Subcommittee, agreed to use PSRC forecasts through 2030 and apply a straight line population projection through 2050.

A5.1.3 Water Conservation

The Regional Wastewater Services Plan (RWSP) anticipated the following consumption of water by different categories:

- Residential: 60 gallons per capita per day (gpcd)
- Commercial: 35 gallons per employee per day (gped)
- Industrial: 75 gped

Water conservation efforts in the region will reduce wastewater flows, so this reduction in flows should be accounted for in the modeling for capital facility needs. These conservation efforts led to lower water usage in the year 2000 than the RWSP forecasts, as evident in the actual water consumption in 2000:

- Residential: 56 gpcd in Seattle and 66 gpcd outside Seattle
- Commercial: 33 gped
- Industrial: 55 gped

The most recent consumption data (2003) shows additional reductions:

- Residential: 52.1 gpcd in Seattle and 62.4 gpcd outside Seattle
- Commercial: 32.4 gped in Seattle and 30 to 33 gped outside Seattle
- Industrial: not available

After discussion, the E&P Subcommittee and the County agreed to use a water conservation planning assumption of a 10-percent reduction in per day consumption by 2010, with no additional reduction thereafter. Water consumption projections are shown in Table A5-1.

Table A5-1. Projected Water Consumption

Type of Consumption	2000 Gallons-per-day Rate	2010 and Beyond
Residential (Seattle)	56	50
Residential (non-Seattle)	66	60
Commercial	33	30
Industrial	55	50

A5.1.4 Degradation

Degradation is the slow change in condition of the sewer collection system that allows an increase in I/I flows. Degradation is due to cracks in the pipe, pulled joints, connections at manholes, construction damage, and/or traffic damage to manholes, etc.

There is little data documenting how fast and how much degradation occurs in a collection system.

The RWSP assumes that I/I flow will increase by 30 percent from 1990 to 2020 due to degradation. For the revised flow predictions with the MOUSE™ (modeling of urban sewers) model, the Earth Tech Team assumed that degradation from 2000 would be 7 percent per decade, with a limit of 28 percent over a 40-year period. For example, if a specific basin has I/I in 2000 of 1,100 gallons per acre per day (gpad), after 10 years it will increase 7 percent to 1,177 gpad.

New sewer systems should degrade less than old systems; thus, degradation is a percentage of the existing I/I. Since a newer system has lower I/I than an older one with respect to flow, it has lower degradation. For example, a newer system may have 1,000 gpad of I/I while an older one may have 10,000 gpad of I/I. Seven percent of 1,000 gpad is 70 gpad, whereas 7 percent of 10,000 gpad is 700 gpad. Using a fixed percentage acknowledges that newer systems degrade less (on a total I/I basis) than older leakier systems.

The County and E&P Subcommittee agreed that no matter what degradation assumption is used to model facility needs, future system monitoring will continue, to ensure facilities are not built sooner than needed.

The County and E&P Subcommittee agreed on a planning assumption of 7 percent degradation per decade starting from 2000 up to 28 percent for existing pipe. For new construction, the degradation assumption of 7 percent per decade will start after the date of construction, with a maximum of 28 percent.

A5.1.5 Septic Conversion

The number and rate at which septic systems are converted to sewered areas impacts system flows and facility needs. As of 2000, approximately 43,000 houses in the regional wastewater service area were estimated to be on septic systems. These are located primarily in the northern, eastern, and southern edges of the County's service area.

The urban growth boundary restricts sewer services to developments within the urban growth area. As the urban growth area's population grows, land values rise. This leads to redevelopment of areas presently served by septic systems. Many of the parcels served by septic systems are larger lots that can be subdivided for further development and converted from septic to sewer.

Other information on the service area includes:

- Total developable parcels: 300,500
- Total sewered parcels: 246,500
- Vacant developable parcels: 11,000

The RWSP projected that 100 percent of the sewerable area will be converted from septic systems by 2020. Several local agency representatives were doubtful that 100-percent conversion would be possible by that date or even by 2030.

The County and E&P Subcommittee agreed on a planning assumption that 90 percent of the area with potential for sewerage as of 2000 will be sewered by 2030 and that 100 percent of this area will be sewered by 2050.

A5.1.6 New System I/I Allowance

Regardless of how well a collection system is constructed, I/I can leak into the system. Historically, an allowance of 1,100 gpad was included in the design flow for both the conveyance and treatment of sewage.

The amount of I/I leakage into the regional system from new sewer connections, sewer mains, manholes, and other facilities impacts system flows and facility needs. Flow monitoring during the wet seasons of 2001/2002 and 2002/2003 showed that the measured amount of peak hourly I/I found in new systems ranges from a low of 270 gpad to 11,200 gpad. Several new systems had less than 800 gpad of I/I.

In contrast, the RWSP assumed that new systems have I/I levels similar to existing systems in 1999 (the rates for those systems ranged from 1,600 gpad to 4,100 gpad). The average I/I for the overall existing system in 2004 was 3,600 gpad.

The County and E&P Subcommittee agreed on an assumption of 1,500 gpad for new system I/I, recognizing that 7-percent degradation per decade increase the I/I to approximately 2,000 gpad after 4 decades.

A5.1.7 Uncertainties Affecting Facility Sizing

Safety Factors

It is common practice and sound engineering judgment to add a contingency or safety factor for sizing facilities to handle unforeseen circumstances. For the regional sewer system, this applies to pipes, pump stations, and treatment plants. Adding a contingency factor allows the system to accommodate higher peak flows without overflows or other unwanted consequences.

Caution must be exercised when using uncertain factors. It is common to include "safety factors" in individual planning components; when these are combined, it can overstate the uncertainties. The increase for a 25-percent contingency factor in flow is roughly a 10-percent increase in cost.

The County and E&P Subcommittee agreed to use a safety factor of 25 percent of additional capacity when sizing facilities. Below are several factors that were considered in using the 25-percent safety factor.

Existing Peak Flow Estimates

An uncertainty that can affect facility sizing needs is the potential for inaccuracy in estimating existing peak flow from monitored data. Due to variances in rainfall monitoring, flow monitoring, and modeling, it is not always possible to predict peak flows with a high level of certainty. While models are calibrated using the best information and technology available, the peak flows that serve as the basis for facility sizing are estimates and are not perfectly accurate.

Potential for Sewering Outside Urban Growth Area

Sewers are required in urban growth areas and these areas are the source of wastewater system flows. However, sewers are needed, and built, outside urban growth area for environmental and/or public health reasons. This can lead to increased peak flows.

"Four to One" Policy for Development along Urban Growth Boundary

Chapter 3 of the County's *Comprehensive Plan* contains a "Four to One" development policy along the Urban Growth Boundary. This policy states that 1 acre of Rural Area land may be added to a city's Urban Growth Area in exchange for a dedication to the County of 4 acres of permanent open space. It is not known how this policy impacts peak flows.

Economic Changes

The local economy represents another possible impact on peak flows, since economic surges tend to bring new industries, companies, and population growth, all of which increase flows in the regional system.

Climatic Changes

Global climate change may impact the frequency and severity of rainstorms in the future. In light of this possibility, prudence suggests an uncertainty factor be applied for the design of facilities so they can handle peak flows.

A5.2 I/I Reduction Assumptions

To determine whether or not a proposed I/I project is cost effective compared to building a new capital facility, specific costs of I/I reduction must be delineated. To this end, the County and local agencies discussed and agreed on assumptions related to I/I reduction in the spring of 2004. The assumptions included costs of various I/I reduction techniques, the percent I/I removal of each technique, and the percent of a given basin that requires rehabilitation.

A5.2.1 I/I Reduction Costs

The pilot projects provided total and average costs for different categories of expenditures for rehabilitation of various system components. Using the pilot project figures, the Earth Tech Team and the County proposed cost assumptions for pipe bursting and cured-in-place pipe (CIPP) rehabilitation of sewer mains, manholes, laterals, and side sewers.

Local agency representatives thought these cost assumptions were low. The E&P Subcommittee and the County agreed by consensus on the following costs for I/I removal. These costs will be used in the cost effectiveness analysis.

- Sewer main rehabilitation: $110 per lineal foot
- Direct disconnect: $3,000 each
- Manhole rehabilitation: $3,600 each
  (NOTE: consider life expectancy in cost effectiveness analysis)
- Lateral rehabilitation: $3,900 each
  (NOTE: based on 1 per lot; size-on-size)
- Side sewer rehabilitation: $3,500 each
- Lateral and side sewer rehab: $6,800 each

As I/I reduction project experience provides additional cost information, these figures will be revisited and revised if warranted.

A5.2.2 Percent Basin Rehabilitated and Percent Reduction

In addition to cost estimates for various I/I rehabilitation techniques, other assumptions are needed to develop cost estimates for I/I reduction projects for cost effectiveness analysis. These include:

- Percent of a basin to be rehabilitated, for example, the number of feet of sewer pipe (sewer main, lateral, or side sewer) or the number of manholes or direct disconnects in a given I/I project
- How much I/I would be removed by each technique

The County and the Earth Tech Team suggested assumptions for these variables to the E&P Subcommittee in the spring of 2004. The development and discussion of these elements was centered on the knowledge gained from the pilot projects. For example, while it may be likely that more than 4 percent of the houses in a model basin could be illicitly connected to the local agency's system, it is not always possible to identify these and, after they are identified, it is not always possible to disconnect them.

As with cost estimating, the E&P Subcommittee and County opted to approve conservative estimates when in doubt. This was intended to ensure that projects found to be cost effective in the first analysis would truly be cost effective.

Table A5-2 shows the percent basin rehabilitated and percent reduction assumptions agreed upon after discussion by the E&P Subcommittee.

Table A5-2. Percent Basin Rehabilitated and Percent I/I Reduction Assumptions

Technique	% Basin Rehabilitated – Final Assumption	% I/I Reduction – Final Assumption
Direct Disconnect (DD)[1]	4%	10%
Replace Everything + DD	95% Main 95% Manhole (MH) 95% Lateral/Side Sewer (Lat/SS) +4% DD	80%
Rehabilitate Public Portions of Basin + DD	50% Main 50% MH 50% Lat/SS +4% DD	40%
Private Property with Some Laterals + DD	50% Lat. & SS 45% SS only	60%

[1]This technique includes removal of roof gutter drains to the sanitary sewer system.

A5.2.3 Cost Estimating Factors

For the cost effectiveness analysis, estimates were needed for several other factors affecting project costs. These include construction cost factors such as utility conflicts, traffic control and dewatering as examples of costs listed in the County's Conveyance System Improvements (CSI) Program.

The County and the Earth Tech Team proposed these factors for the E&P Subcommittee's consideration. Table A5-3 shows the agreed upon cost estimating assumptions.

Table A5-3. Cost Estimating Assumptions

Cost Estimating Factors	Final Assumption
Allied Cost Factor	52% of estimated construction costs *(NOTE: May need to add mitigation costs for environmental or other concerns)*
Common Work Savings (For Total System Replacement)	Use 42% allied cost factor *(NOTE: May need to add mitigation costs for environmental or other concerns)*
Utility Conflicts	None (included in construction costs of pilot projects)
Traffic Control	None (if no traffic control needed): $0 Avg: $5/LF Main Heavy: $10/LF Main
Dewatering	Project-specific
Sales Tax	8.8% of construction estimate (or according to jurisdiction's tax rate)
Project Contingency	30% of construction estimate

A5.2.4 Financial Assumptions

To determine cost effectiveness, costs and benefits of I/I reduction projects must be compared with the costs of planned CSI and treatment plant projects. Because the proposed I/I reduction projects and the planned CSI and treatment plant projects occur over the next 50 years, the cost effectiveness analysis must account for the timing differences as well as the cost of the County's capital funding. Calculating the costs and benefits of an I/I removal project or capital improvement project involves predicting:

- The increase in the cost of goods and services over time, or the inflation rate; and
- The County's cost of capital, for example, bond rates, or the discount rate.

Using these two factors, the net present value of the costs and benefits can be calculated for each I/I reduction project and planned project. The net present value is the current value of the costs and benefits occurring in the future. The RWSP uses an inflation rate of 3 percent and a discount rate of 6 percent. NOTE: the importance of the discount and inflation figures lies not in the actual numerical level of each but in the difference between the two numbers.

Discount Rate

The discount rate used in the cost effectiveness analysis is the County's cost of capital based on the difference between the historical bond rates and inflation. The historical bond buyers' index from 1980 to 2003 was 7.33 percent, though it has been below 6 percent since 1996. Over the same period the average difference between inflation and the bond rates was 3.15 percent. The E&P Subcommittee requested that the County present two separate cost effective analyses of I/I removal projects using discount rates of 6 percent and 5.5 percent.

Inflation Rate

Inflation is the increase in the cost of goods and services over time. The average inflation rate from 1984 to 2003 was 3.12 percent. The County and the E&P Subcommittee agreed to use a 3-percent inflation rate for the cost effectiveness analyses.

Operations and Maintenance Cost Savings

The E&P Subcommittee also reviewed the regional collection system, pump station, and treatment system operation and maintenance costs. These are needed because the cost effectiveness analysis will use operation and maintenance cost savings in the analysis in addition to the capital costs.

For the cost effectiveness analysis, it was agreed to use the same assumptions that were used in the RWSP with certain specific updated information related to operation and maintenance of: new pipes, new pump stations, new sewage storage facilities, and treatment plants.

The specific numbers are included in the summary Table A5-4 below.

Summary of I/I Program Assumptions

The final planning assumptions are listed in Table A5-4.

Table A5-4. Final Assumptions

Subject	Final Assumption
Design flow	• 20-year peak flow + 5%, based on Sea-Tac 60-year rainfall record (the additional 5% is the factor to accommodate the difference between the best fit curve and the third-highest 20-year flow)
Future Population	• Puget Sound Regional Council (PSRC) forecast through 2030; apply straight line projection through 2050
Water conservation (base flow projections)	• 10% reduction by 2010; no additional reduction thereafter
Degradation	• Existing pipe: 7% per decade starting from 2000 up to 28% • New construction: 7% per decade starting after date of construction, up to 28%

Subject	Final Assumption
Septic conversion	• 90% of unsewered but sewerable area in 2000 sewered by 2030 • 100% sewered by 2050
New system I/I allowance	• 1,500 gallons per acre per day (gpad)
Sizing of facilities	• 25% safety factor (when sizing facilities, a safety factor of 25% of additional capacity will be used)
I/I reduction costs	• Sewer main rehabilitation: $110 per linear foot • Direct disconnect: $3,000 each • Manhole rehabilitation: $3,600 each (NOTE: consider life expectancy in cost effectiveness analysis) • Lateral rehabilitation: $3,900 each (NOTE: based on 1 per lot; size-on-size) • Side sewer rehabilitation: $3,500 each • Lateral and side sewer rehab: $6,800 each
Percent basin rehabilitated	• Direct disconnect (DD): 4% • Replace everything + DD: 95% sewer main, 95% manhole, 95% lateral/side (Lat/SS) Sewer (Lat/SS) + 4% DD • Rehabilitate public portions of basin + DD: 50% sewer main, 50% manhole, 50% Lat/SS + 4% DD • Private property with some laterals + DD: 50% Lat/SS, 45% SS only
Percent I/I reduction	• Direct disconnect (DD) 10% • Replace everything + DD 80% • Rehabilitate public portions of basin + DD 40% • Private property with some laterals + DD 60%
Cost estimating factors	• Allied cost factor: 52% of estimated construction costs (NOTE: May need to add mitigation costs for environmental or other concerns) • Common work savings (for total system replacement): Use 42% allied cost factor *(NOTE: May need to add mitigation costs for environmental or other concerns)* • Utility conflicts: None (included in construction costs of pilot projects) • Traffic control: None (if no traffic control needed), Avg: $5/linear foot sewer main, Heavy: $10/linear foot sewer main • Dewatering: Project-specific

Subject	Final Assumption
	• Sales tax: 8.8% of construction estimate (or according to jurisdiction's tax rate) • Project contingency: 30% of construction estimate
Discount rate	• 6% and 5.5%
Inflation rate	• 3%
Operations and maintenance (O&M) analysis	Same methodology as the Regional Wastewater Service Plan (RWSP). Update the following numbers: • New pipes: $.15 per linear foot annually • New pump station: $4,104 *million gallons per day + $60,384 • New storage facility: $34,091 *million gallons + $4,546 • Treatment plant: $15,000 to $30,000 per million gallons per day of average annual flow reduction. Plant-specific. Covers energy and disinfection costs. * Reflected total O&M at the plants.